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ASPHALT FOR OFF-STREET PAVING AND PLAY AREAS, 3RD EDITION.

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THIS PAMPHLET DISCUSSES THE ALTERNATIVE METHODS, APPLICATIONS, AND TECHNICAL CONSIDERATIONS FOR OFF-STREET PAVING AND PLAY AREAS. OFF-STREET PAVING INCLUDES--(1) ASPHALT-PAVED PARKING AREAS, (2) ROOF DECK PARKING AREAS, (3) ASPHALT-PAVED DRIVEWAYS, (4) ASPHALT-PAVED SERVICE STATION LOTS, AND (5) SIDEWALKS. THE DISCUSSION OF PLAY AREAS INCLUDES--(1) PLAYGROUNDS, (2) TENNIS COURTS, AND (3) ASPHALT SWIMMING POOLS. SUGGESTIONS ARE GIVEN IN EACH AREA FOR SITE PREPARATION, DRAINAGE, ASPHALT MIXTURE, THICKNESS, BASE COURSE, AND SURFACE TREATMENT. A REFERENCE LIST IS GIVEN OF OTHER ASPHALT SOURCE BOOKS. (MM)

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ASPHALT FOR OFF-STREET PAVING AND PLAY AREAS

DRIVEWAYS

PARKING AREAS

SIDEWALKS

PLAYGROUNDS

TENNIS COURTS

SWIMMING POOLS

EF001108

THE ASPHALT INSTITUTE

THIRD EDITION MAY 1965

Manual Series No. 9 (MS-9)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Asphalt For

OFF-STREET PAVING

and

PLAY AREAS

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Part I

OFF-STREET PAVING

INTRODUCTION.—In practically every center of human activity there exists an imperative need for economical, efficient parking facilities. The need for vehicle parking space has grown with each increase in the vehicle population.

In some large cities where space is at a premium, vertically-constructed parking structures are replacing the open-air lots. (See Section B of this Part I for roof deck parking.) In the sprawling suburban developments, vast areas of asphalt pavements are providing space for shoppers and business people, and for commuters who transfer to public transportation into the city.

A.—Asphalt-Paved Parking Areas

ASPHALT SURFACE TYPES FOR PARKING AREA PAVING.—There are four types of asphalt surfacing widely used for passenger car parking areas.

(1) *Asphalt Concrete.* Asphalt concrete can be laid easily and quickly at the parking site. This is particularly advantageous in congested urban areas, where a minimum of construction time is of special benefit. Asphalt concrete is a mixture of asphalt cement and graded aggregate (crushed stone, gravel, slag, sand, mineral dust, etc.). The mixture is made at controlled hot temperatures in a hot-mix asphalt plant and hauled by truck to the construction site where it is spread over a firm foundation and compacted while still hot.

(2) *Asphalt Macadam Penetration.* Asphalt macadam penetration consists of using a coarse, open-graded aggregate produced by crushing and screening stone, slag, or gravel. This is spread in the required

thickness and compacted. Asphalt is applied by spraying in controlled quantities. This is then covered with a smaller sized aggregate and again rolled.

(3) *Cold-laid Asphalt.* Cold-laid asphalt may be similar to asphalt concrete except that in place of using a hot mixture of asphalt cement and aggregate, various combinations of liquid asphalt and cold aggregate are used, rendering the mixture pliable, permitting shipment long distances and allowing placement and compaction after long periods of time.

(4) *Asphalt Surface Treatment.* Asphalt surface treatments serve well in light-duty parking areas but should be used only as a temporary expedient under heavy-duty conditions. It consists of application of an asphaltic material to a prepared base with a cover of mineral aggregate, producing a thickness of not more than one inch.

Asphalt concrete is recommended for parking of heavy trucks and trailers, with penetration macadam as the second choice. For lighter duty service cold-laid asphalt or surface treatment may be used if the foundation is satisfactory and the funds available are limited.

In some localities asphalt blocks are available which are suitable for heavy-duty service when placed on a firm foundation—they are especially adaptable to paving steep ramps and roof parking areas.

Tables 1 and 2 show thickness for the various courses of pavements for parking areas.

EARTH WORK.—For new construction the area to be paved should be graded to the required cross-section and brought to a firm, unyielding surface by rolling with an approved power roller. Areas inaccessible to a power roller should be thoroughly compacted by other acceptable methods.

DRAINAGE.—In the construction of all asphalt paved parking areas the design and construction should incorporate provision for both surface drainage and subsurface drainage as necessary. There should be a minimum slope of two percent.

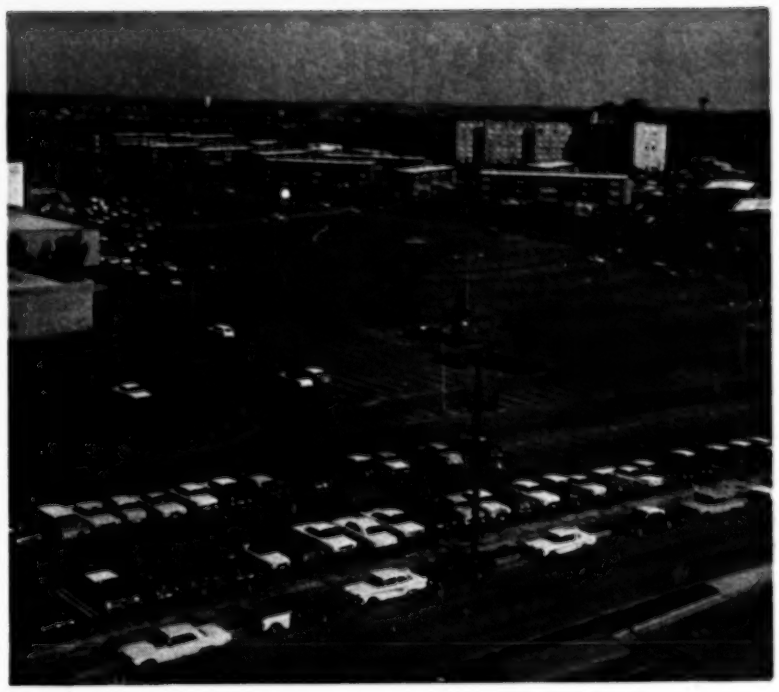

Figure 1—An Asphalt-Paved Parking Lot

INSULATION COURSE.—When non-asphalt base or subbase is used on plastic clay soils an insulation course should be provided as shown in Tables 1 and 2 and should consist of free-draining material placed on the prepared subgrade and compacted by a power roller weighing not less than five tons. Places inaccessible to power rolling should be thoroughly consolidated by vibratory compaction or by hand tamping.

B.—Roof Deck Parking Areas

INTRODUCTION.—The urgent need for space for parking facilities in congested areas has stimulated the development of roof deck parking.

There is not universal agreement as to the best method of waterproofing and paving roofs for use as parking areas. However, there is agreement that:

Table 1—PAVEMENT THICKNESS FOR PARKING AREAS FOR PASSENGER CARS

	THICKNESS REQUIREMENTS IN INCHES							
	FULL DEPTH ASPHALT CONCRETE		ASPHALT CONCRETE SURFACE		PLANT-MIX SURFACE USING LIQUID ASPHALT		ASPHALT SURFACE TREATMENT	
	Asphalt Concrete Surface	Asphalt Concrete Base [1]	Asphalt Concrete Surface	Crushed Rock Base [2]	Asphalt Plant-Mix Surface	Crushed Rock Base [2]	Asphalt Surface Treatment	Crushed Rock Base [2]
Gravelly or sandy soils, well drained	1	2–3	3	2	4.5*	2	1**	6–8
Average clay loam soils, not plastic	1	3–4	3	2–4	4.5*	2–4	1**	8–10
Soft clay soils, plastic when wet	1	4–5	3	4–6***	4.5*	4–6***	1**	10–12***

[1] *Prime required on subgrade.*
[2] *Prime required on base.*
* *Must be spread and compacted in layers not exceeding 1½ inches in depth and the volatiles (petroleum solvents or water) allowed to evaporate before the next layer is placed. Also, a seal coat may be required as a final surfacing.*
** *Economical but relatively limited service life. Usually less than 1 inch thick.*
*** *Two inches of coarse sand or stone screenings recommended between subgrade and base as an insulation course.*

Table 2—PAVEMENT THICKNESS FOR PARKING AREAS FOR HEAVY TRUCKS

	FULL DEPTH ASPHALT CONCRETE		THICKNESS REQUIREMENTS IN INCHES					
			ASPHALT CONCRETE SURFACE		SURFACE TREATMENT ON PENETRATION MACADAM		PLANT-MIX SURFACE USING LIQUID ASPHALT	
	Asphalt Concrete Surface	Asphalt Concrete Base [1]	Asphalt Concrete Surface	Crushed Rock Base [2]	Asphalt Surface Treatment	Asphalt Penetration Macadam Base [1]	Asphalt Plant-Mix Surface	Crushed Rock Base [2]
Gravelly or sandy soils, well drained	1.5	3–5	4.5	2–4	1*	5–7.5	7**	2–4
Average clay loam soils, not plastic	1.5	5–6	4.5	4–6	1*	7.5–8.5	7**	4–6
Soft clay soils, plastic when wet	1.5	6–8	4.5	6–10***	1*	8.5–11***	7**	6–10***

[1] *Prime required on subgrade.*
[2] *Prime required on base.*
* *Usually less than 1 inch thick.*
** *Must be spread and compacted in layers not exceeding 1½ inches in depth and the volatiles (petroleum solvents or water) allowed to evaporate before the next layer is placed. Also, seal coat may be required as a final surfacing.*
*** *Two inches of coarse sand or stone screenings recommended between subgrade and base as an insulation course.*

(1) Careful attention should be given to grade control to insure good run-off and prevent puddling or collection of water;

(2) Specially designed roof drains should be spaced so that water has only a short distance to travel;

(3) Flashing details are important to prevent leakage where the roof deck meets the parapet wall;

(4) Construction and expansion joints and cracks in the roof deck should be sealed, chiseling them out if necessary, and filling with an elastic and highly adhesive joint filler usually composed of asphalt and rubber; and

(5) The deck surface should be mopped with asphalt and covered with some sort of membrane or building paper.

There are two types of roof deck paving discussed in this section—slab and pavement with a built-in movement plane and slab and pavement bonded together. For additional information refer to "Paving Roof Decks and Industrial Floors," by Lansing Tuttle, Information Series No. 130 (IS-130), The Asphalt Institute.

FREE-MOVEMENT-PLANE CONSTRUCTION.—This type of construction provides a distinct free movement plane between the structural roof slab and the subsequent pavement. The construction steps are:

(1) A positive bond breaker, such as lime, fine sand, or portland cement, is provided between the concrete deck to be covered and the built-up roofing to allow for freedom of movement between the concrete deck and the pavement.

(2) A conventional built-up roof utilizing four or five plies of lightweight roofing felts is placed without final flood coat and aggregate cover.

(3) A very light tack coat, using a hard grade of asphalt (diluted SS-1h or SS-Kh), is applied to the top felt layer.

(4) A minimum of two inches of hot asphalt concrete is placed in one course as the wearing surface, using very dense-graded asphalt concrete with a maximum size aggregate of approximately ⅜ inch.

BONDING ROOF DECK AND PAVEMENT. —To bond the pavement to the roof deck after sealing the cracks and joints, a conventional four to five ply built-up roof is applied using asphalt roofing felt, glass fiber membranes, or cotton fabric, each layer, except the surface of the top layer, thoroughly mopped with asphalt. This is then covered with one to three inches of a dense asphalt concrete as above.

Another method is to use an asphalt membrane which contains mineral filler and asbestos or other fibers for body and strength. The asphalt cement is a low penetration grade in the 40-50 range. Great pains are taken to insure a uniform thickness, and no further operation is allowed on the membrane until it has fully cured in place.

The cured membrane is overlaid with two lifts of asphalt concrete which is a fine impervious mix with high asphalt content and maximum agregate size of ⅜ or ¼ inch. The total thickness of mix would not exceed three inches. The effort is to get an impervious mixture which will weather well with the lack of kneading traffic and have a stability of plus 500 pounds Marshall.

Small rollers or sidewalk rollers usually are used because of the restricted working area and the maximum allowable live loads for the building. This probably means a roller not exceeding three to four tons. Small hand operated electric or gasoline vibratory compactors are used to work around areas inaccessible to rollers.

CAUTION

Asphalt concrete paving mixtures should be placed over asphalt membranes only. Differences in temperature susceptibility when asphalt concrete is placed over a membrane of a different material may result in melting of the membrane, gas blisters, and flushing of the membrane to the surface. Also, lack of consolidation and slipping of the surfacing can occur.

ASPHALT PANELS.—Some of the reinforced molded asphalt panels, similar to those used for reservoir linings or possibly thinner, occasionally are used as the waterproofing member.

POROUS LAYER BENEATH ASPHALT SURFACE.—A porous layer is used sometimes on top of the built-up layers of asphalt and membranes before the asphalt concrete wearing surface is placed. This might consist of a very open-graded intermediate course, followed by the asphalt concrete courses as in the above. With this type of construction, care must be exercised in providing catch basins, down drains, or other methods for water removal. The previous layer functions as a stratum through which percolated or condensed water may flow to drains. It also serves as a bond breaker to allow for freedom of movement between the portland cement concrete roof and the asphalt concrete surface. The customary roof flashings are necessary.

SURFACE DRESSING.—Some specifications provide for a surface dressing in the nature of an emulsified asphalt slurry on top of the surface course of asphalt concrete as follows:

Surface Dressing Materials: Where a surface dressing is to be used, the materials and proportions recommended are as follows:

Portland Cement	94 lb. (1 cu. ft.)
Silica Sand (60 mesh)	170 lb. (2 cu. ft.)
Emulsified Asphalt (SS-1h or SS-Kh 10 gal.)	83 lb. (1.33 cu. ft.)
Water (7.5 gal.)	62 lb. (1 cu. ft.)
Total weight, wet	409 lb.
Total dry weight, compacted	314 lb. (2.50 cu. ft.)

Cement: Any commercial grade is satisfactory, special grades such as "early strength," plastic types, special fine grind, etc., should not be used.

Silica Sand: A commercial product obtainable from building supply dealers.

Emulsified Asphalt: Grade SS-1h or SS-Kh conforming to currently published Asphalt Institute specifications for the grade used.

Water: Any domestic water supply.

NOTE

This mixture should be prepared in a small drum mixer, and the mixture may be stored for several days in cans with tight covers if desired. The mixture should be spread with a squeegee so as to cover completely the asphalt concrete.

Some specifications may require a fog seal of emulsified asphalt SS-1, SS-1h, SS-K or SS-Kh diluted, if necessary, with up to three or four parts of water and applied on the surface course of asphalt concrete after compaction is completed.

PAVING OF RAMPS TO ROOF-DECK PARKING AREAS.—Because of the good run-off due to the slope of ramps, it is not necessary to place the layers of built-up roofing on ramps. Usual practice is to finish the portland cement concrete slab with a rough, corrugated surface. Binder and surface courses are then laid as described above for the roof-deck parking area. A gradual transition should be provided between the ramp and the practically level roof-deck parking area. Care must also be used in this area to prevent slippage of the asphalt concrete courses.

C.—Asphalt-Paved Driveways

INTRODUCTION.—Asphalt-paved driveways are commonly used in most residential areas. These driveways are easy and economical to construct. When properly built, they have a long service life and require little maintenance.

They have a particular advantage in that they resist ice and snow formation and are unaffected by the corrosive action of ice melting salts. In addition, these asphalt paved driveways make excellent play areas for children.

SELECTION OF DESIGN CROSS-SECTION.—In selecting an asphalt-paved driveway the home owner should take into consideration requirements that the pavement will have to fulfill. In addition, the conditions of the native soil, drainage and availability of materials must be taken into account.

Table 3—PAVEMENT THICKNESS FOR DRIVEWAYS FOR PASSENGER CARS

	THICKNESS REQUIREMENTS IN INCHES							
	FULL DEPTH ASPHALT CONCRETE		ASPHALT CONCRETE SURFACE		PLANT-MIX SURFACE USING LIQUID ASPHALT		ASPHALT SURFACE TREATMENT	
	Asphalt Concrete Surface	Asphalt Concrete Base [1]	Asphalt Concrete Surface	Crushed Rock Base [2]	Asphalt Plant-Mix Surface	Crushed Rock Base [2]	Asphalt Surface Treatment	Crushed Rock Base [2]
Gravelly or sandy soils, well drained	1	2–3	3	2	4.5*	2	1**	6–8
Average clay loam soils, not plastic	1	3–4	3	2–4	4.5*	2–4	1**	8–10
Soft clay soils, plastic when wet	1	4–5	3	4–6***	4.5*	4–6***	1**	10–12***

[1] *Prime required on subgrade.*
[2] *Prime required on base.*
* *Must be spread and compacted in layers not exceeding 1½ inches in depth and the volatiles (petroleum solvents or water) allowed to evaporate before the next layer is placed. Also, a seal coat may be required as a final surfacing.*
** *Economical but relatively limited service life. Usually less than 1 inch thick.*
*** *Two inches of coarse sand or stone screenings recommended between subgrade and base as an insulation course.*

After these factors have been determined the structural section should be designed in conformance with the recommendations in Table 3.

TYPICAL DRIVEWAY CROSS-SECTION.—The width of the asphalt pavement should be at least eight feet. In those cases where the driveway is used for a combination driveway and entrance, however, a width of ten feet is recommended. Figure 3 shows a typical driveway cross-section. The use of drain tile on either side of the base course is optional, depending on the amount of rainfall and the slope of the driveway. The use of the drain tile is highly recommended, however, for all locations where water would tend to collect at the edge of the driveway pavement.

SUBGRADE PREPARATION.—The foundation or subgrade for the driveway should receive careful preparation depending largely upon the type of soil that exists within the confines of the driveway. Generally, sand or granular soils provide a better foundation than those of clay or silt.

Sometimes in new construction, debris, consisting of small waste pieces of wood, metal containers, or other materials, are buried around the building. These materials upon rotting will leave a void in the filled-in area. This is poor practice and may ultimately result in settlement of the driveway. Care should be exercised to see that debris material is not included in any of the filled-in areas where the driveway will be placed. If such material is found, it should be removed and the area refilled with suitable soil.

It is also good practice to sterilize the subgrade soil before placing the overlying layers. Commercial sterilants containing chemical compounds such as sodium chlorate, borate, or arsenate will prevent the germination of weed seeds in the pavement structure.

After such fundamental requirements have been met, the next step is to lay out the driveway, establishing the lines and grades that best suit the surrounding terrain and the convenience of the user.

Figure 2—An Asphalt-Paved Driveway

The soil should be compacted thoroughly prior to constructing the pavement.

DRAINAGE.—In establishing a drainage system it is necessary to see that the water is drained away from the residence or building, using an underground system of pipe if necessary. In a free-draining sand or gravel-type soil it is usually not necessary to construct an elaborate drainage system. In silt and clay it will be necessary to use every precaution to see that water is not ponded alongside of the building or the area adjacent to the driveway foundation. Roof drainage from downspouts should be piped far enough away from the driveway to make certain that water does not seep under the pavement. The driveway should be sloped for fast removal of surface water. The recommended minimum grade is two percent.

BASE CONSTRUCTION.—All types of asphalt pavement require some sort of base between the wearing course and the subgrade. The purpose of this base is to spread the load that is transmitted through the

surface course onto the subgrade. Local materials are often acceptable for the base.

If the subgrade is of good quality, such as sand or gravel with low clay content, or if a granular subbase at least five inches thick is placed over poor subgrade, one inch of asphalt concrete base can be used for each two inches of granular base and three inches of subbase called for in the design. If these substitutions are made the total thickness of asphalt courses should be not less than three inches.

The base course must be placed true to lines, grades, and cross-sections, and brought to a firm, unyielding surface by rolling with the heaviest type of compacting equipment that is available and is practical to use in the

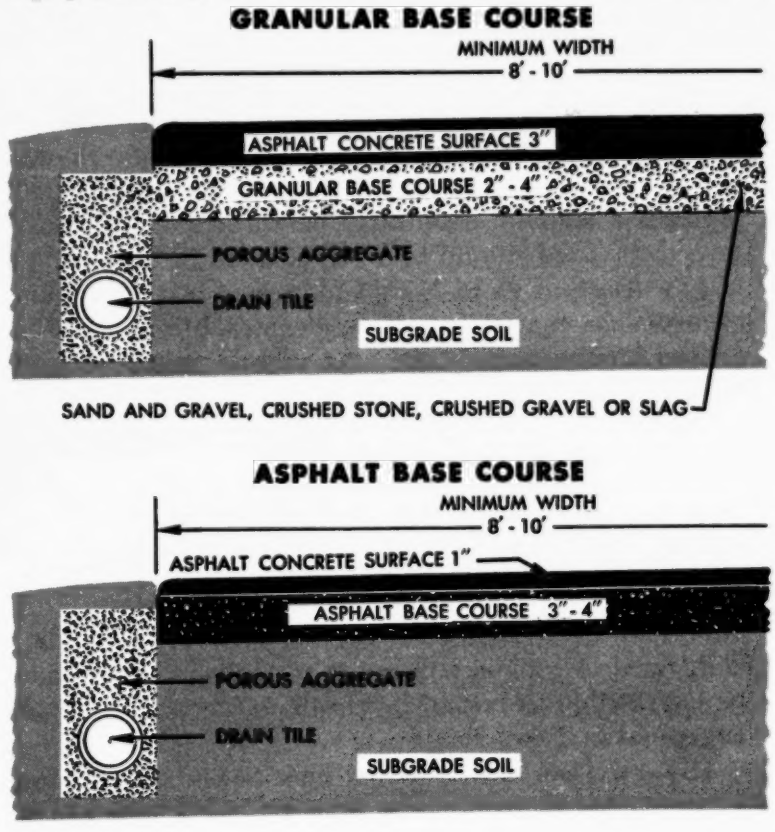

Figure 3—Typical Driveway Cross-Section

area where the driveway is being constructed. In the absence of special requirements, it is safe practice to use the local highway department, city or town specifications. It should be remembered at this stage that the serviceability and good performance of the driveway is dependent upon the establishment of a good base course.

ASPHALT WEARING COURSE.—There are a number of types of asphalt surfacing for driveways that are in general use. Here only three of the many types are suggested. Modifications which will fit local conditions, however, may be made in any of the types. They are: (1) Asphalt Concrete (Hot Mix), (2) Asphalt Cold Mix, and (3) Surface Treatment.

(1) **Asphalt Concrete (Hot Mix).** This is the most durable type of pavement, the one that will give the greatest service with the least maintenance cost.

Asphalt concrete consists of well-graded aggregates and asphalt mixed in a central plant. It is mixed hot and laid while hot (225°-325°F). This pavement, when rolled, is virtually waterproof, easy to clean, and presents a smooth, even-textured surface. The thickness to be used should be as designated in Table 3.

(2) **Asphalt Cold Mix.** Cold mix is a combination of asphaltic materials and aggregates prepared in a central mixing plant. The aggregate is mixed without heating with either a liquid or emulsified asphalt. The mix may be laid while cold and, for that reason, has found considerable favor where work is apt to progress slowly.

The texture of cold mix is of a slightly open nature. Cold mix is quite similar in appearance to the pavement usually found in parks and recreational areas. This pavement, even after a considerable amount of traffic, is inclined to remain somewhat porous. While it may be laid as thin as one inch, the thickness should be as suggested in Table 3.

(3) **Surface Treatment.** This consists of a thin wearing course, usually less than an inch in thickness, composed of two or more applications of liquid asphalt covered with mineral aggregates. Surface treatment is

an economical type of pavement that serves quite well for a limited period of time. It may be used as one step in stage construction.

A surface treatment provides a water-tight wearing surface adequate for light traffic. When first constructed, some loose aggregate will remain on the surface, but after several weeks the loose pieces may be swept off the pavement.

D.—Asphalt-Paved Service Station Lots

INTRODUCTION.—Asphalt-paved service station lots are attractive and economical. They will last for many years with a minimum of maintenance if they are designed properly and constructed according to recommended practice.

Design is preceded by an investigation of drainage and subgrade conditions and includes the best use of local materials. Good construction procedure involves working only in favorable weather, proper preparation of materials, adequate compaction, and correct installation of drainage facilities and utilities.

BACKFILL.—The backfill over buried storage tanks and pipelines can be a source of heavy maintenance if it is not properly placed. Granular material should be used as backfill in excavations for tanks and in ditches for pipelines and utilities. If the surrounding subgrade soil is impervious, drainage should be provided to keep water from accumulating in the granular backfill. To prevent future differential settlement, the backfill must be tightly compacted in thin layers by vibratory compactors.

DRAINAGE.—Underdrainage should be installed unless the subgrade soil is of a character (gravelly or sandy) that drains well. With a proper cross-section, quick runoff of surface water can be assured, either to the outer limits of the paved area, to a shallow gutter through the center, or to drop inlets spaced so that standing water will not be left on the surface at any time. The outer

edges of the area should be designed in such a manner as to keep water from seeping under the surface.

The slope to all gutters or drop inlets should be not less than one inch in ten feet. For parking areas, where water can be drained in two directions from a centerline, the slope should be as much as ¼ inch to the foot.

SUBGRADE PREPARATION.—All unstable materials encountered, such as saturated subgrade soils, logs or tree stumps, should be removed before embankment or fill soils are placed. When construction is carried out on filled areas which have been built up over a long period of time, soundings should be made to determine the type and stability of the subgrade soil. This information should be used to insure that the materials are well compacted within the top four to six feet and thereby avoid any undue settlement caused by further deterioration of unstable materials. Heterogeneous fills should be scarified to a depth of at least one foot, thoroughly mixed, and recompacted.

Embankments should be placed in layers not exceeding eight inches loose depth. Each lift should be compacted with equipment best suited for the material being placed; sheepsfoot rollers for fine grained soils, pneumatic-tired rollers or vibratory compactors (rollers or shoe-type) for granular material.

The subgrade should be finished to a firm and smooth surface, conforming to the final grades within a tolerance of ± ½ inch. Pockets or humps that would show up in the final surface should not be permitted.

PAVEMENT THICKNESS.—Tables 1 and 2 can be used as guides for minimum designs for service station lots. Table 2 should be used if several heavy trucks daily are expected to use the pavement. If the subgrade is in extremely poor condition, tests should be made and the pavement designed according to the procedures outlined in *Thickness Design—Asphalt Pavement Structures for Highways and Streets*, Manual Series No. 1 (MS-1), The Asphalt Institute.

BASE CONSTRUCTION.—See Page 12.

ASPHALT WEARING COURSE.—Although there are several types of asphalt surfacing that can be used for service station paving, The Asphalt Institute recommends dense-graded asphalt concrete with the grades of asphalt cement suggested in Table II-2 in the Institute's publication, *Specifications and Construction Methods for Asphalt Concrete and Other Plant-Mix Types,* Specification Series No. 1 (SS-1), The Asphalt Institute.

E.—Sidewalks

GENERAL.—The use of asphalt provides an inexpensive method of constructing durable sidewalks and walkway areas. There are several treatments that can be used, however, the most common for the surfacing of the sidewalk area is asphalt concrete. It can be readily placed on a foundation requiring the minimum amount of preparation. While not absolutely necessary, the appearance of the completed sidewalk will be considerably improved by the use of wooden side forms, when hand placing methods are used, to delineate edges neatly. If desired, the sidewalk surface can be made green or red by application of special pigmented asphalt mastics.

WIDTHS.—The minimum width should generally be three feet which permits two persons to walk abreast. The width of four or five feet is desirable and should be provided on locations having much foot traffic. Uniformity in width is desirable but not necessary, narrowing being permissible where construction otherwise would be costly.

DRAINAGE.—Walks should be sloped ¼ to ⅜ inch per foot across the pavement and about twice this much or more on the adjacent sod area to assure proper run-off.

SIDEWALK SURFACING.—Sidewalks may be surfaced with the following: asphalt concrete, asphalt macadam, asphalt cold mix, asphalt mixed-in-place, and asphalt surface treatments.

Selection of the surface type in respect to service life and cost are approximately the same as for highways. Asphalt concrete is frequently the first choice because of long life, smoothness and the ease of construction with the small pavers now available.

THICKNESS.—Thickness of asphalt sidewalks are shown in Figure 4. Local condition of soil, moisture, frost, and available materials may modify these thicknesses.

BASE COURSE MATERIALS.—Crushed stone, slag, gravel, pit-run material, sand or cinders are usually suitable for sidewalk bases. At driveways and road crossings the base courses shown in Figure 4 should be increased so as to be adequate for the traffic anticipated.

COMPOSITION OF MIXES FOR SIDEWALKS.—Asphalt concrete mixtures for sidewalks are usually of the dense or fine-graded types. Asphalt Institute Specification Series No. 1, *Specifications and Construction Methods for Asphalt Concrete and Other Plant-Mix Types*, covers complete specifications for materials used in asphalt concrete and other mix compositions which might be used. Asphalt Institute Manual Series No. 2, *Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types*, covers the design of asphalt mixes. Sidewalk paving for the lighter type of traffic should contain from one to two percent more asphalt in the mixture than is usually used in roadway pavements.

COMPACTION OF SIDEWALK MATERIALS.—For sidewalk construction with asphalt mixtures it is essential that the mix be thoroughly compacted. Normally, conventional highway compaction equipment is recommended.

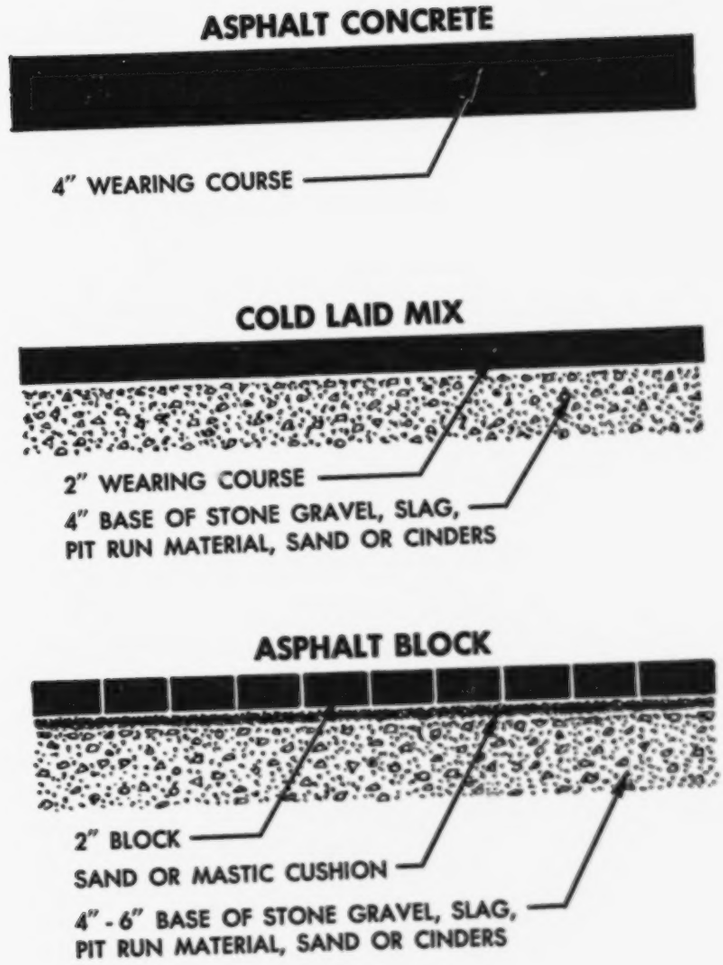
ASPHALT CONCRETE
4" WEARING COURSE
COLD LAID MIX
2" WEARING COURSE
4" BASE OF STONE GRAVEL, SLAG,
PIT RUN MATERIAL, SAND OR CINDERS
ASPHALT BLOCK
2" BLOCK
SAND OR MASTIC CUSHION
4" - 6" BASE OF STONE GRAVEL, SLAG,
PIT RUN MATERIAL, SAND OR CINDERS

Figure 4—Thickness Design for Sidewalk Construction

MAINTENANCE OF SIDEWALKS.—A fog seal every five or ten years is usually the only maintenance needed on asphalt concrete sidewalks.

Part II

PLAY AREAS

A.—Playgrounds

15.14 PLAYGROUND SURFACING.—Pavement is, of course, not the immediate requirement for all playgrounds. Where it is, however, the following outline guide may help to shape the planning of those responsible.

Asphalt surface treatment, penetration macadam, and hot and cold mix surfacings have been used for playgrounds and, except for such modification as may be necessary because of restrictions due to area, the same procedure should be followed as when building a highway. For most situations a foundation thickness of from four to six inches will be ample. Properly graded, good quality crushed stone, slag, and gravel all make excellent bases and drain readily because of their porous nature. Foundations also may be constructed by stabilizing suitable natural soils with asphaltic products. Except for surface treatment, a surface course thickness of from 1½ to 2 inches is desirable, from the standpoint of durability. The surface texture as a rule should be fine grained. In addition to those types which use the usual mineral aggregates, experiments have been made with sawdust, cork, or rubber fillers.

Proprietary products have been developed and widely accepted using an emulsified asphalt base combined with selected pigments and fillers for squeegee application on asphalt concrete. These materials develop a tight seal with no loose material remaining. They permit easy cleaning and maintenance, and develop a smooth, non-skid surface.

ASPHALT-SAWDUST SURFACE.—For an asphalt-sawdust surface the procedure is essentially similar to surface treatment, and may be an original treatment over a waterbound surface course or a retreatment over an established surface. It may be either a light or heavy treatment. All the sawdust should pass a No. 4 sieve in

the former and a ½ inch sieve in the latter and should not contain shavings or splinters. The surface should be thoroughly rolled with a light roller until the sawdust is well embedded. Emulsified asphalt or light, rapid-curing liquid asphalt may be used as a binder. For the heavy treatment, either heavy rapid-curing liquid asphalt, RC-800, or a hot asphalt cement may be used. The asphalt cement should have a penetration between 200 and 300, and be applied at a temperature between 275°F and 325°F.

After application of the asphaltic material, coarse sawdust should be spread and rolled until thoroughly embedded. The amount of asphalt should be about three-tenths gallon per square yard, with the sawdust added in thin applications and broomed about until no more will adhere.

ASPHALT CORK SURFACE.—For an asphalt cork surface the course is laid to a compacted depth of one to two inches, and usually upon an asphalt base or binder course. The mix should be composed of granulated cork, ¼ inch maximum diameter, sharp coarse sand, limestone dust, and an asphalt cement of 60-70 penetration. The following weight proportions have been used successfully in surfacing an exceptionally large municipal playground:

	PERCENT
Clean sharp sand	70 to 72
Ground cork	5 to 6
Limestone dust	7 to 8
Asphalt cement	15 to 17

PAVING DETAILS.—Full details on procedures involved in the paving of playgrounds, with the various asphalt types mentioned, are available upon request to the nearest Asphalt Institute Office. A list of Institute Offices and Member Companies will be found in the end papers.

Figure 5—Asphalt-Paved Playground, Washington, D.C.

B.—Tennis Courts

GENERAL.—Asphalt tennis courts are fast, true, and available for play immediately after rain. Where funds are limited, courts can be constructed on a sound base with an asphalt concrete leveling course, then finished with a fine-textured, enriched asphalt concrete. Proprietary products have been developed for multiple-layers constructed to very close tolerances and these courts, in color, are popular with players and athletic authorities.

SURFACE TYPES.—Surfaces should be made from sand asphalt mixtures such as Asphalt Institute mix types VII or VIII. See Asphalt Institute Specification Series No. 1, *Specifications and Construction Methods for Asphalt Concrete and Other Plant-Mix Types.*

The use of color on asphalt tennis courts is becoming increasingly popular. Favorite colors are grass-green and tile red, or a combination of both. A number of proprietary products are marketed for this purpose, but they must be tested to be sure they are compatible with asphalt and will weather without bleeding or discoloration. These special finishes are water-based materials and should be diluted to proper consistency before application. Best results are obtained by spreading with a long-handled hair broom in several applications.

DRAINAGE.—Proper drainage is of the utmost importance in the construction of a good court. Where funds are limited it is much better to place a low-cost surface than to neglect the foundation. In sandy or gravelly soil, underdrainage may not be required, but in heavy clay soils it is desirable to dig a ditch entirely around the court, with such bottom slope and outlet as will prevent accumulation of water. The ditch should be two or three feet in depth, with a perforated corrugated iron pipe, or open clay tile at the bottom, and should then be backfilled with broken stone or coarse gravel to within a few inches of the surface.

LAYOUT.—The paved area of a tennis court should be 60 by 120 feet, which gives ample room outside the limits of a doubles court, 36 feet by 78 feet for play.

It is preferable to have the entire surface in one plane but, where this is not practicable because of the topography, the slope may drop each way from the net. The usual gradient is one inch in 10 feet or, for a single plane, one end of the court is one foot lower than the other; while for a slope either way from the net, each end is six inches lower than center. In the construction the subgrade should be leveled and finished to such an elevation that when the base and surface course are applied later the finished surface will be slightly above the adjacent sodded

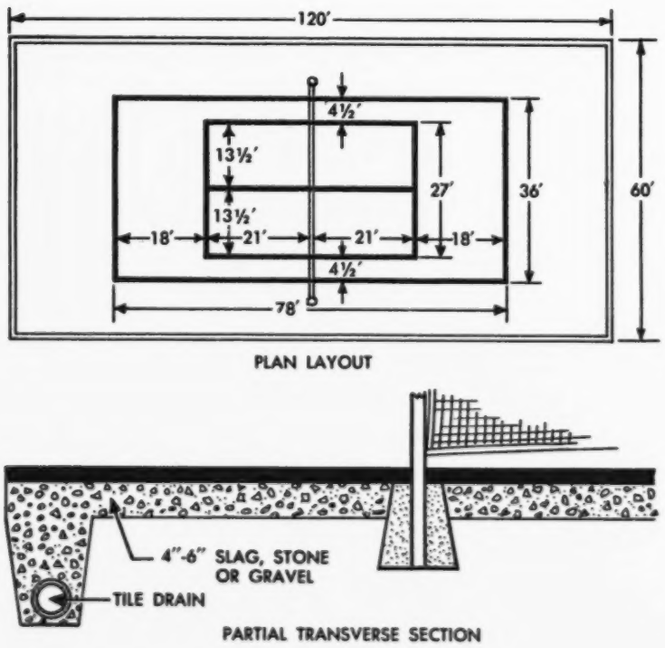

Figure 6—Design Layout for Tennis Court

area. Where fills are made, they should be compacted thoroughly, and preferably allowed to stand under the weather until subjected to several heavy rains, before placing the surface.

BASE COURSE.—For the base course good quality steam cinders are quite satisfactory, and a compacted depth of four to six inches usually will be sufficient. Where crushed stone, slag or gravel base courses are constructed, it is desirable to place first a layer of screenings or sand, so as to consolidate and harden the subgrade and prevent the infiltration of earth into the coarser material. A one inch depth of screenings well worked into the earth will be sufficient, with three to six inches compacted depth of stone, slag or gravel. The base course should be rolled thoroughly and uniformly. Base courses also may be constructed by stabilizing suitable natural soils with asphaltic products. A superior type foundation may be obtained by placing asphalt base two to three inches in compacted depth.

ASPHALT MACADAM AND SURFACE TREATMENT.—Where funds are limited, macadam surfaces have been constructed using standard procedures. But, due to difficulty in obtaining surfaces smooth enough for good play, they are not widely accepted.

MULTIPLE-LAYER COLD MIX CONSTRUCTION.—Using proprietary products, a system of multi-layer construction provides a very high type weather-resistant surface. Layout is important, with an asphalt base and good drainage for sound foundation. These courts are constructed in one plane, sloped one inch in 15 feet from one end to the other. The four-inch minimum thickness base may be emulsified asphalt penetration construction, although other types of asphalt-treated base are acceptable. For the leveling and surface courses, cold mixes consisting of carefully blended aggregate and filler, with specially prepared emulsified asphalts and sufficient water, are prepared for proper placement by screed. The leveling course is 1½ inches thick, followed by a finer

textured ½-inch surface course. After each course is dried, it is rolled to maximum compaction. The surface is checked with a 10-foot straightedge, permitting a maximum variation of ⅛ inch. Then the court is flooded, and low spots marked. Fine-textured mixes are applied, feather-edged, to fill the low spots.

Successive applications of factory-compounded products, containing the proper balance of emulsified asphalt binder, selected mineral fillers, and selected coloring are applied by squeegee to obtain a smooth, non-skid texture, and complete sealing action. Where color fastness is desired, special proprietary products are used in the final application. These special products contain no asphalt, but are compatible with asphalt surfacing and are applied at a rate of 10-15 gallons per 1,000 square feet, using long-handled hair brooms.

ASPHALT CONCRETE SURFACE.—Other high type surfaces are constructed with plant mixes. Coarse-graded mixtures are employed for the intermediate course, but the upper inch of surface course should be preferably a dense sand-asphalt mixture. Such mixtures may be accurately struck with a template to true cross section and profile, and will permit of slight adjustments to correct base irregularities. Because of the lighter traffic on a court as contrasted with a road or street, slightly more asphalt of somewhat softer consistency is recommended for the mix. Any cracking or drying out of surface with age can be remedied by light asphalt surface treatment at the rate of 0.1 gallon per square yard of cutback asphalt, RC-70, or quick-setting emulsified asphalt, RS-1 or RS-2K, and 10 pounds of sand cover. Proprietary products also have been developed for sealing cracked and weathered surfaces.

C.—Asphalt Swimming Pools

GENERAL CONSIDERATIONS.—Pools have various types of paved surfaces, but *asphalt* because of

its superior waterproof characteristics is particularly well adapted for such use. The best asphalt construction calls for a dense-graded hot-laid surface course, although well sealed asphalt macadam has also been successfully used. It is important that the surface course be laid on a substantial well-drained base so as to eliminate any back pressure from ground water when the pool is periodically emptied for cleaning. In cold climates, depending upon the thickness of ice formation, the pool may be drained to any desired level to produce a skating rink.

ASPHALT POOL AT WALLINGFORD.—As part of its park and recreation system, the city of Wallingford, Connecticut, in 1960 completed a record size asphalt swimming pool. The pool has an over-all water surface area of more than 60,000 square feet and a depth ranging from a maximum three feet at the shallow end to a maximum nine feet, six inches in the diving pool.

The Wallingford pool existed for ten years as a community swimming pond, fed by a constant flow of water from a small brook. However, silt, filtering in with the flow from the stream, created a muddy bottom which, in turn, discolored the water. It was decided to line the pond with a dense asphalt concrete to permit periodic cleaning.

After removing about 500 cubic yards of accumulated silt, the engineer added some one thousand cubic yards of gravel to the natural sand foundation. On top of this was placed four to six inches of compacted stone base, gradation ranging from 1¼ inches down to ¾ inches. This base was surfaced with three inches of dense asphalt concrete, placed in two courses—two inches of intermediate mix and one inch of surface mix. After spray priming, this surface was treated with an emulsified filler before painting with an acrylic finish.

VERSATILITY IN USE.—Asphalt-paved pools can provide large swimming areas at relatively low cost. For example, the Wallingford pool is roped off into three

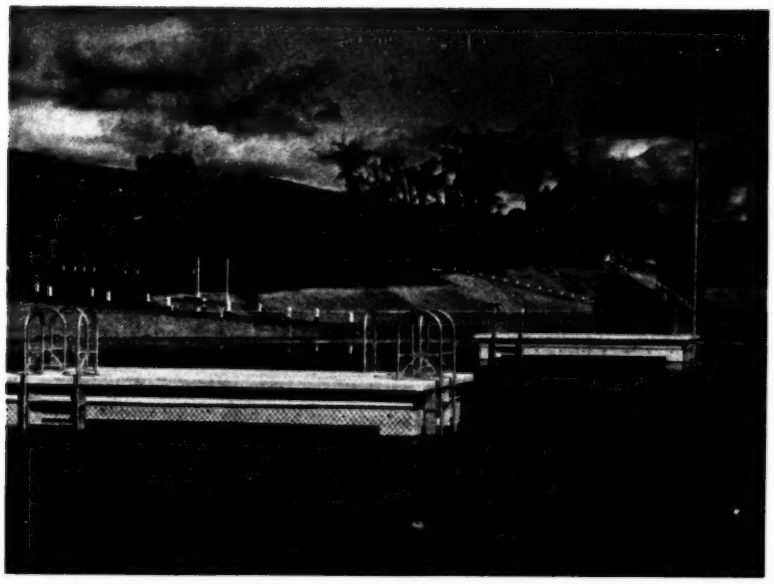

Figure 7—Asphalt-Paved Swimming Pool, Montpelier, Vt.

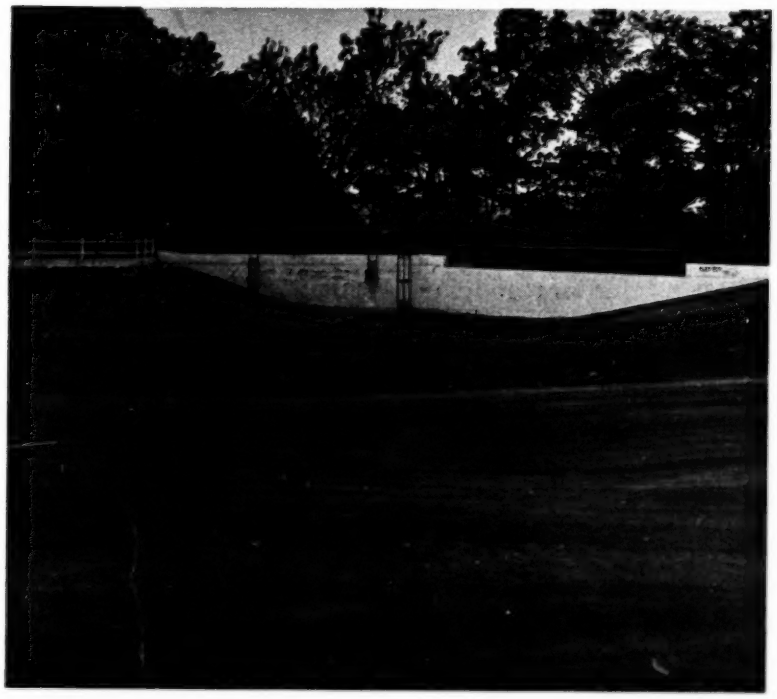

Figure 8—Asphalt-Paved Pool, Wallingford, Conn.

areas. Approximately one-third of the pool, for tots and non-swimmers, slopes to a maximum depth of three feet. Beyond the guard rope is a full 50-meter racing pool ranging in depth from three to eight feet. Thereafter, the bottom slopes abruptly to a large diving area.

ADVANTAGES OF ASPHALT.—Superior qualities of asphalt-paved swimming pools include smoothness, pleasing appearance, and exceptionally good weathering qualities. These latter are based upon asphalt's resistance to water, sunlight, air, pressure, weight, freezing, thawing, chlorine, and abrasion.

RESURFACED SWIMMING POOL.—Another very large swimming pool, now asphalt-surfaced, is located at Crescent Hill, Louisville, Kentucky. This pool, 175 feet long by 150 feet wide, oval in shape, originally of rigid-type surface construction, had cracked and disintegrated so badly that it was decided to resurface with asphalt. Construction procedure consisted of patching, priming with a tack coat of a rapid-setting liquid asphalt, and resurfacing with one and one-half inches of asphalt concrete. After the bottom of the pool had been paved, using standard paving equipment and a 10-ton roller, the surface was coated lightly with aluminum paint, and two coats of white marine then applied.

REPAVING WITH ASPHALT.—The resurfacing of the large Crescent Hill swimming pool was so successful that a year later it was decided to repave the cracked and disintegrating surface of the nearby wading pool. This was effectively salvaged by patching, priming, and placing, over its approximately 2,000 square feet of worn out rigid-type paving, a smooth, waterproof surface of one and one-half inches of sheet asphalt.

ASPHALT WADING POOLS.—An asphalt wading pool may be visualized as a huge, shallow, waterproof platter, with a gradual slope to a suitable depth, possibly about eighteen inches. For this surface, three inches of hot-mix sheet asphalt or a fine-graded asphalt concrete, properly placed and compacted, on a well-

drained foundation, will provide the necessary waterproofness and adequately smooth texture.

It is important that the foundation for the pool be carefully constructed by first shaping the earth subgrade to proper conformation and then densifying, by thorough compaction, at least eight or nine inches of the subgrade material. As there should be provision for draining, the bottom of the pool should be sloped slightly so that it may be quickly cleaned.

An asphalt wading pool, as the surface is not affected by freezing, will serve equally well for a skating rink in winter.

REFERENCES

Additional information concerning the uses of asphalt discussed in this Manual will be found in the following Asphalt Institute technical publications:

(1) *Specifications and Construction Methods for Asphalt Concrete and Other Plant-Mix Types*, Specification Series No. 1 (SS-1)

(2) *Thickness Design—Asphalt Pavement Structures for Highways and Streets*, Manual Series No. 1 (MS-1)

(3) *Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types*, Manual Series No. 2 (MS-2)

(4) *Asphalt Plant Manual*, Manual Series No. 3 (MS-3)

(5) *Asphalt Mulch Treatment*, Manual Series No. 7 (MS-7)

(6) *Asphalt Paving Manual*, Manual Series No. 8 (MS-8)

(7) *Asphalt in Hydraulic Structures*, Manual Series No. 12 (MS-12)

(8) *Asphalt Surface Treatments and Asphalt Penetration Macadam*, Manual Series No. 13 (MS-13)

(9) *Asphalt Protective Coatings for Pipe Lines*, Construction Series No. 96 (CS-96).

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